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NATIVE AMERICAN PRACTICES IN NATIONAL PARKS: A DEBATE

Simulated Indigenous Management: A New Model for Ecological Restoration in National Parks

by M. Kat Anderson and Michael G. Barbour

Native American land management practices could revive the processes needed to maintain the classic ecosystems and cultural integrity of our nation parks.

Many ecologists and land managers now realize that certain landscapes require active management to maintain ecosystem integrity. The need for active land management in national parks can be traced back at least as far as the 1963 and the completion of *Wildlife Management in the National Parks*, better known as the Leopold Report (Leopold and others 1963). In recommending that each large national park restore "the biotic associations...[and] conditions that prevailed when the area was first visited by the white man," the authors acknowledged that "most biotic communities are in a constant state of change due to natural or man-caused processes of ecological succession," and that in these successional communities, "it is necessary to manage the habitat to achieve or stabilize it at a desired stage" (Leopold and others 1963). The report's authors recognized that successional communities, such as grasslands, aspen groves and oak savannas, harbored unique plant and animal life and that these communities were shaped by natural disturbances, such as fires, floods, or hurricanes. They also concluded that active management would be necessary in many cases because the remaining fragments of natural areas might be too small and isolated to support the disturbance regimes that once perpetuated them.

While the Leopold Report accepted the concept that disturbance was characteristic of most ecosystems, it failed to differentiate between disturbances caused by abiotic factors, which tend to occur randomly across a landscape, and disturbances attributable to indigenous peoples, which tend to occur non-randomly across the landscape and through time. Instead they followed the thinking of most academic ecologists and conservationists and overwhelmingly focused on disturbances created by abiotic factors. This bias continues to this day in most national parks.

In this essay, we argue for a shift that emphasizes disturbances created by indigenous peoples in the pre-Columbian landscape. We believe that there are areas within various national parks where nature has been influenced by long-term Indian occupation, management, and stewardship. These areas require active natural resource management and cultural resource management that would reconstruct indigenous disturbances and include approximations of those disturbances as means of restoring and maintaining park landscapes. These landscapes would be the testing grounds for ecological field experiments that would require an integration of social and biological sciences, ecological modeling, and indigenous, place-based forms of knowledge in order to replicate or simulate indigenous harvesting patterns and land management practices.

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Management Models

Many of the classic landscapes of our national parks—the coastal prairies and oak woodlands of Redwood National Park, the ponderosa pine and oak-meadow mosaic of Yosemite Valley, and the subalpine meadows of Mount Rainier National Park—were shaped by the unremitting labor of generations of indigenous peoples (Clark 1894, Allen 1922, Sugihara and Reed 1987). The fact that these landscapes and many others are changing radically in the absence of active management shows that they were not self-sustaining. Landscapes with such a land use history have important implications for National Park Service employees involved in restoration projects because restoration involves not only the reintroduction of plants and animals known to exist in the area historically but the reinstatement of both cultural and natural processes that shaped the model community (Anderson 1996).

Current National Park Service natural resource managers and restorationists frequently attempt to restore a landscape to a wilderness state so as to preserve its primeval character. The management goal is to restore natural processes and allow them to function unimpaired by human interference. While this goal fits within the founding legislation of National Park Service (NPS), the 1916 Organic Act, which states that the purpose of the parks is "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (U.S.C., title 16, sec. 1.), it also has much in common with the 1964 Wilderness Act. With this in mind, we are calling the conceptual model that forms the basis for current National Park Service natural resource management and restoration practices the Simulated Wilderness Management Model (SWMM).

We propose that some areas within our national parks be set aside, protected, restored, and managed under a different model than the SWMM. These areas would be restored and managed through the valuing and application of historical indigenous traditional ecological knowledge and land management practices in combination with Western scientific knowledge. We call this conceptual model the Simulated Indigenous Management Model (SIMM). Under this model, specific Indian-ecosystem associations, such as gathering and management regimes, would be reconstructed and maintained as defined units within designated park areas. At present, park managers have no name for such areas, but these landscapes could be called "eco-cultural landscapes" in that they combine a concern for perpetuation of both natural and cultural values. They would serve as a middle ground between areas designated as "wilderness" and other areas that are managed as living museums or "cultural landscapes." These landscapes would be areas that are no longer used by tribal peoples and would be chosen for experimentation using techniques that simulate the actions of indigenous peoples. This means that the actions taken by national park managers will promote changes that resemble or approximate those induced in the past by activities of indigenous peoples for the major purpose of maintaining and restoring biodiversity at the population, community, and landscape scales.

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Other areas that are defined by cultural resource managers as "ethnographic landscapes," ("landscapes associated with contemporary groups and typically are used or valued in traditional ways" [National Park Service 2002]), could be co-managed with tribes to restore, maintain, and enhance natural resources important to their cultures. In this case, a SIMM could be used to reconstruct indigenous knowledge and practices in specified areas, but the management and restoration would be a collaborative effort of cultural and natural resource managers and ecologists with contemporary Native American tribes. Native American tribes that have ancestral ties to national park lands could enter into co-management agreements within parks (see Ruppert, this issue). Designated areas that meet specific criteria and have been traditionally very important to a specific tribal group could be managed collaboratively. In such areas, indigenous people would apply traditional harvesting and management techniques within the park. To date, Hawai'i Volcanoes, Mount Rainer, Badlands, Zion, Lassen Volcanic, Yosemite, and other national parks have entered into such agreements with tribes, although these efforts mainly focus on plant collection and joint monitoring, not traditional management and experiments.

Disturbance and its Role in Ecosystems

The authors of the Leopold Report implicitly accepted a concept of nature that emphasizes the pervasive importance of disturbance in creating the array of landscapes in our national parks. The acceptance of the idea that natural disturbance is pervasive among most ecosystems has grown to become a paradigm among ecologists during the past several decades (White and Pickett 1985, Botkin 1990, Pickett and others 1992). Disturbance, in this context, means a discrete event that changes the physical environment and, by doing so, changes the structure of some ecosystem, plant community, or population (White and Pickett 1985). A single disturbance can affect hundreds of square miles, a few acres, or one square foot. Large-scale disturbances are caused by wildfires, hurricanes, ice storms, diseases, droughts, landslides, and volcanic eruptions. Localized disturbances include the tunneling and throwing of earth by a single gopher, the footfall of a large animal that compacts soil or creates a depression, and the death of a tree that leaves a sunny gap in the canopy and a mound of soil below.

One consequence of species having evolved differential tolerances to, or requirements for, any particular disturbance is that biodiversity is high so long as the disturbance continues to occur. If the disturbance is removed or suppressed, then those species that require disturbance are disadvantaged by competition from other species normally excluded by the disturbance. As a result, disturbance-dependent species become less abundant and eventually drop out of the community. If the disturbance were to occur more frequently than its historic range of variation, then only a few of the most tolerant species would survive and all others would drop out of the community.

The relationship between biodiversity and disturbance, as theorized by ecologists, has been called the "intermediate disturbance hypothesis" (Huston 1979). According to this hypothesis, the maximum number of species present in a community or ecosystem occurs at some intermediate frequency or intensity of disturbance. Periodic disturbances often maintain a community type that would disappear without the disturbance. Such a temporary community is called a successional community, and it is normally replaced by a community that is more stable and long-lived (a climax community). Native Americans in different tribes often set fires to keep areas in earlier successional states because these states produced greater plant diversity and great landscape heterogeneity—important considerations in widening the array of useful species to maintain indigenous subsistence economies.

Let's take Yosemite Valley for an example. The level of biodiversity there, in terms of understory herbs, trees, birds, and mammals, is lower in the climax forest than in the pine-dominated successional stage, a pattern in accordance with the intermediate disturbance hypothesis. The heterogeneous microenvironment can satisfy both pioneer and climax species, as well as provide habitat for successional species, resulting in a high level of species richness. Until the past century, surface fires started by either lightning strikes or indigenous people repeatedly burned beneath the pine-oak forest every 3-15 years, according to an examination of fire scars stored and dated in the tree-ring record (Barbour and Minnich 2000) (Figures 1a and b). Under such a fire regime, the successional pine-oak forest is maintained and the climax forest cannot replace it. The timing of the understory fire is too frequent to permit white fir establishment, and the intensity of the fire is too low to kill pines ten years old or older. The diversity, growth rate, and reproductive output of edible and usable successional plants are sustained (Figure 2).

The recognition that wildfires in many ecosystems can be seen as natural, predictable, and important to the maintenance of biodiversity took many years to become widespread enough to affect national park management. Prescribed thinning and burning in many forests of western states is now practiced or at least desired, awaiting budgetary changes necessary to fund this active management. The proposed method for reintroduction of fire, however, follows the SWMM rather than the SIMM. That is, the fire regime targeted for restoration is a fire regime based on natural ignitions, not on natural plus human-caused ignitions. We hypothesize that the biotic consequences of pursuing this narrowed target can be profoundly negative at the population, community, and landscape scales.

The reason SWMM-based fire management is less than optimal is because the variation of fire regimes that result from Indian and natural fires is greater than that generated by natural fires alone. Indian-caused fires recur with greater frequency, they focus around non-random loci, they are often smaller in extent than natural fires, and their intensity may be lower than natural fires. The forest ecologists Martin and Sapsis (1992) have written that a landscape is shaped by the variety of fires that occur within it. Each landscape unit is the result of its particular level of "pyrodiversity." They conclude that fire suppression management has eliminated only the coolest burning, easiest-to-control fires, resulting in a decrease in the diversity of fires that occur in wildlands. They argue that any management that reduces pyrodiversity will also reduce biodiversity.

Native Americans as Agents of Disturbance

There are three broad realms in which Native Americans acted as agents of environmental change in many plant communities across North America: 1) ecosystem modification and maintenance, 2) plant dispersal, and 3) genetic modification (Anderson 1997a).

Native Americans as Agents of Ecosystem Modification and Maintenance

Through the use of time-tested management techniques, such as burning, coppicing, pruning, sowing, tilling, weeding, irrigating and selective harvesting, Native Americans expanded and maintained suitable habitat for desired species without necessarily altering the plants' character traits.

Native Americans managed plants and animals to produce specific ecological consequences that, in turn, met a wide variety of cultural objectives or desired outcomes (Pyne 1982). These ecological consequences were registered at different scales and include the following: increase abundance and density of edible tubers, greens, and mushrooms; decrease incidence of insects and diseases of plant foods and basketry material; increase quality and quantity of medicinal and ceremonial plants; increase quantity and quality of material for basketry and cordage; decrease detritus; increase epicormic branches and adventitious shoots for household items, fish weirs, clothing, hunting and fishing traps, and weapons; drive, lure, and smoke out animals; increase forage for animals; recycle nutrients; decrease plant competition; and maintain specific plant community types at early to mid-successional stages.

Fire was the most significant, effective, efficient, and widely employed man-

Figure 1a. Lower Yosemite Valley from Union Point, 1866. Note the meadows in the valley and the low density of trees. This successional pine-oak landscape with large meadows was maintained by both lightning and Indian-set fires. *Photo by C.E. Watkins, courtesy of the Yosemite National Park Research Library*

Figure 1b. Lower Yosemite Valley from Union Point, 1961. The landscape has changed to a white fir-incense cedar-pine landscape with dwindling meadows due to a long history of fire suppression. *Photo taken by R.P. Gibbens, courtesy of the Yosemite National Park Research Library*

agement tool used by Native American tribes (Lewis and Anderson 2002). The major type of fire set by the Indians was a light surface fire. Such fires frequently burned off a shallow litter layer and the aboveground parts of herbs and shrubs, but did little or no damage to roots, bulbs, or large tree trunks (Bonnicksen 2000, Stewart 2002).

Frequent burning by Indians created park-like hardwood and coniferous forests with widely spaced, large-diameter trees (for example, valley oak savannas in California, mixed conifer forests of the West, oak-chestnut and pine forests of the East) and also opened stands of smaller-diameter trees (for example, oak-hickory forests in the center of North America and longleaf pine forests of the southeastern United States) (Bonnicksen 2000). Excessive fuel accumulations—which in turn would create conditions that inhibit seedling establishment and encourage diseases and insects—were prevented by frequent Indian burning. Fires created bare mineral soil, heightening seed germination rates of annual herbs and vegetative reproduction of perennial herbs. This burning often created a two-layered forest of overstory trees and an understory of grasses and forbs, ultimately leading to an increase in plant species diversity (Figure 2). Many of the plants growing in the understory provided important uses to tribes.

Underground swollen stems (bulbs, corms, tubers, and rhizomes) of many species of forbs were gathered with a digging stick for many purposes. Huge quantities of these plant parts were gathered, potentially causing considerable soil disturbance, affecting seedbed preparation, and ultimately affecting plant abundance, density, and community composition (Anderson 1997b). Native Americans assert, and we hypothesize, that digging these storage organs was actually a form of tillage, increasing the size of the gathering patch, aerating the soil, lowering weed competition, and increasing the density of plants (Figure 3). In conjunction with digging, traditional gathering sites were set afire to enhance quantity and quality of the underground organs. Different tribes purposefully left bulblets and cormlets, and harvested after the plants had gone to seed to ensure future production (Jenness 1935, Turner and Efrat 1981, Kari 1987).

Tribes burned and weeded areas to maintain seral plant communities that would otherwise disappear through the normal process of succession (Figure 4). These include oak savannas, coastal prairies, freshwater marshes, montane meadows, and aspen forests (Abrams 1992, Anderson in press, Bicknell and others 1992). We hypothesize that Native Americans heightened the number and types of plant communities in these shifting mosaics through their burning, transplanting, weeding, tillage, and sowing practices.

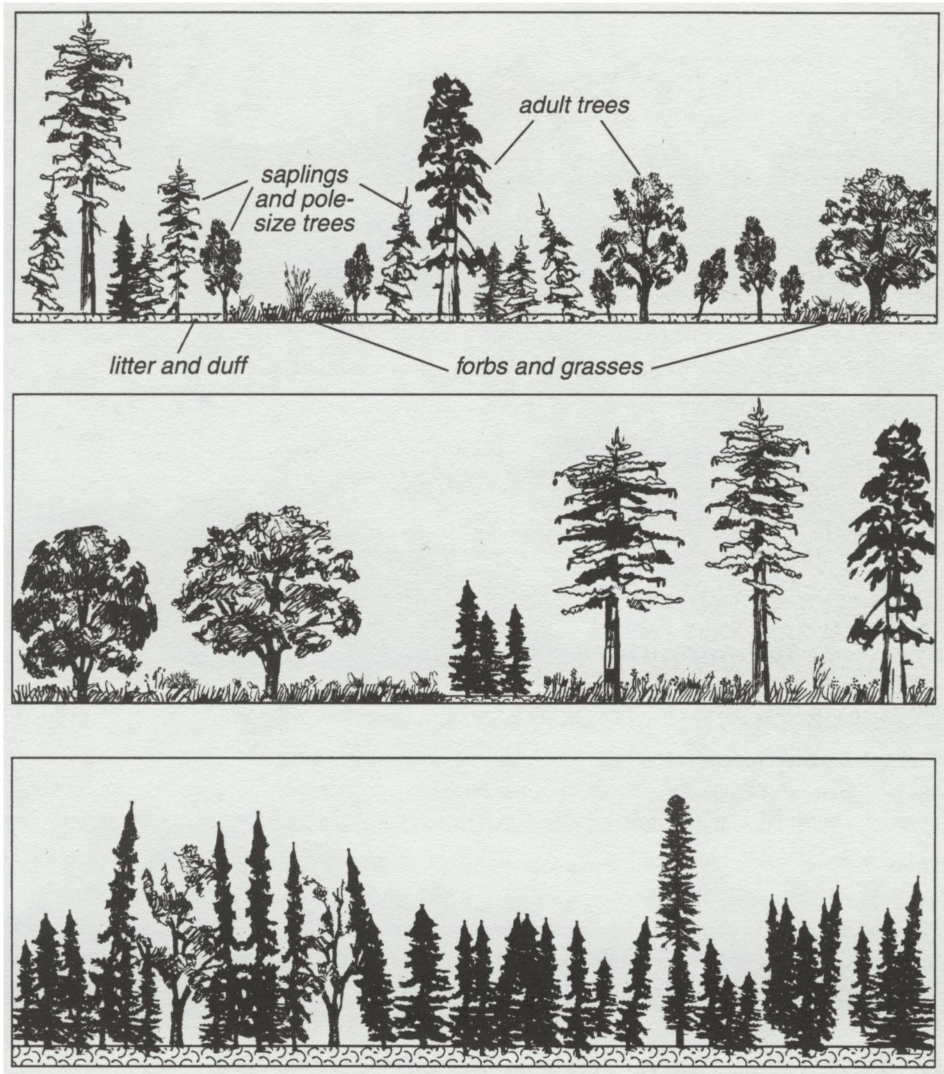

Figure 2. A hypothetical scenario of three different forest types created by three different fire disturbance regimes. The top drawing illustrates a forest that is the result of periodic lightening fires. Note the size, spacing, and composition of the trees and the amount of litter. The middle drawing depicts a forest type created by the interaction of lightening fire and burning by Native Americans. Note the decrease in tree density, the lack of litter, and the increased diversity of understory species. The bottom drawing exemplifies a forest in which fire disturbance of all types has been suppressed. Note the significant increase in litter, lack of understory species, and the increased tree density.

Native Americans as Dispersal Agents

Native Americans were conscious and sometimes inadvertent agents of plant dispersal that has rearranged the distribution of some species and created unusual plant distributions and polymorphisms. For example, the Hopi sometimes transplanted cottonwood (*Populus* spp.), willow (*Salix* spp.), and cattail (*Typha angustifolia*) into neighboring washes, while wild potatoes (*Solanum jamesii*) were semi-cultivated in Hopi cornfields (Whiting 1939). Maygrass (*Phalaris caroliniana*) has been found at numerous archaeological sites in Kentucky, eastern Tennessee, and Illinois far outside its natural distribution (Cowan 1978). The Cahuilla and probably other tribes of the Southwest planted the seeds of the desert fan palm (*Washingtonia filifera*) at oases (Cornett 1987).

Native Americans as Agents of Genetic Modification

Indians modified the gene pools and genetic structures of plants through selective harvesting, tillage, transplanting, and burning. Unconscious human selection of plants was operative if any protection was given to any stand or clump of vegetation because of the palatability of its fruits, seeds, or roots (Sauer 1967). Hybridization was increased by scattering of seed or transplanting of plants brought in from other localities to new sites where closely related species grew. Native Americans may have assisted these new hybrids further by promoting their establishment in disturbed areas. Over hundreds to thousands of years, specific genotypes of many plant species that had widespread use were undoubtedly selected by Native American groups and, therefore, probably still exhibit suites of character traits that are adapted to small-scale human disturbance regimes. For example, marshelder (*Iva annua*) is an oily-seeded annual that is native to west-central Illinois where it occurs in open, disturbed, wet floodplain habitats. It has been found at archaeological sites dating back 7,300 years ago. There is an archaeological record for the gradual increase in marshelder achene size that provides persuasive evidence for cultivation and possible domestication (Asch and Asch 1978).

Figure 3. Circa 1910. Cheyenne women using hardwood digging sticks to dig large Indian breadfruit (*Pediomelum esculentum*). The Cheyenne and other Plains tribes ate this tuber, which is also known as pomme blanche or "white potato." Many tribes used digging sticks to unearth bulbs, corms, and tubers. In the process, they also aerated the soil and severed propagules thereby caring for the plants and expanding their populations. Digging in combination with burning was commonly practiced and had subtle, yet significant, effects on populations of edible plant species. *Photo taken by Elizabeth Grinnell near Lame Deer, Montana, courtesy of the Southwest Museum, Los Angeles, California*

Implementing SIMM-Based Management

To restore the original biotic richness of North America, we must continue to use the SWMM—setting aside, protecting, and managing natural areas that largely excludes human use. But we also must begin a process of restoration and enhancement within segments of national parks and reserves that incorporates the indigenous human factor as proposed in the SIMM. This latter suggestion will require answers to the following multifaceted question: How did gathering, tending, burning, pruning, and other forms of management affect populations, plant communities, landscapes, and entire vegetation types?

We believe that answers to this question could be obtained by interdisciplinary studies that would include 1) ethnoecological assessments, 2) ecological modeling, and 3) ecological field experiments. Such collaborative work would fit within the guidelines of NPS policy on cultural landscapes and ethnographic research (National Park Service 2001).

Recent interdisciplinary research that combines knowledge from the realms of the social, physical, and biological sciences as well as the humanities has produced more detailed reconstructions of the interactions between indigenous people and the natural environment in North America and elsewhere. Known as historical ecology (Crumley 1994, Balée 1998, Egan and Howell 2001), this work involves highly qualified, interdisciplinary teams of social, physical, and biological scientists and humanists working cooperatively with contemporary tribal peoples in specific regions. One such study completed for Yosemite National Park demonstrated the use of archaeological data, charcoal concentrations, and pollen cores to gain an understanding of long-term environmental change in Yosemite Valley (Anderson and Carpenter 1991). In this study, archaeological evidence showed fluctuations in human population density while pollen studies revealed that there were parallel fluctuations in botanical resources. Taken together, this information provided evidence for environmental manipulations by Native Americans. An example of a proposed interdisciplinary study involves conducting pyrodendrochronological studies that compare fire-scarred tree density at known archeological sites with fire-scarred tree density from random landscape samples (Keeley and Stephenson 2000). We suggest that by integrating archaeological, ethnographic, and biological evidence it may be possible to tease out the contribution of Native American burning from the fire-scar

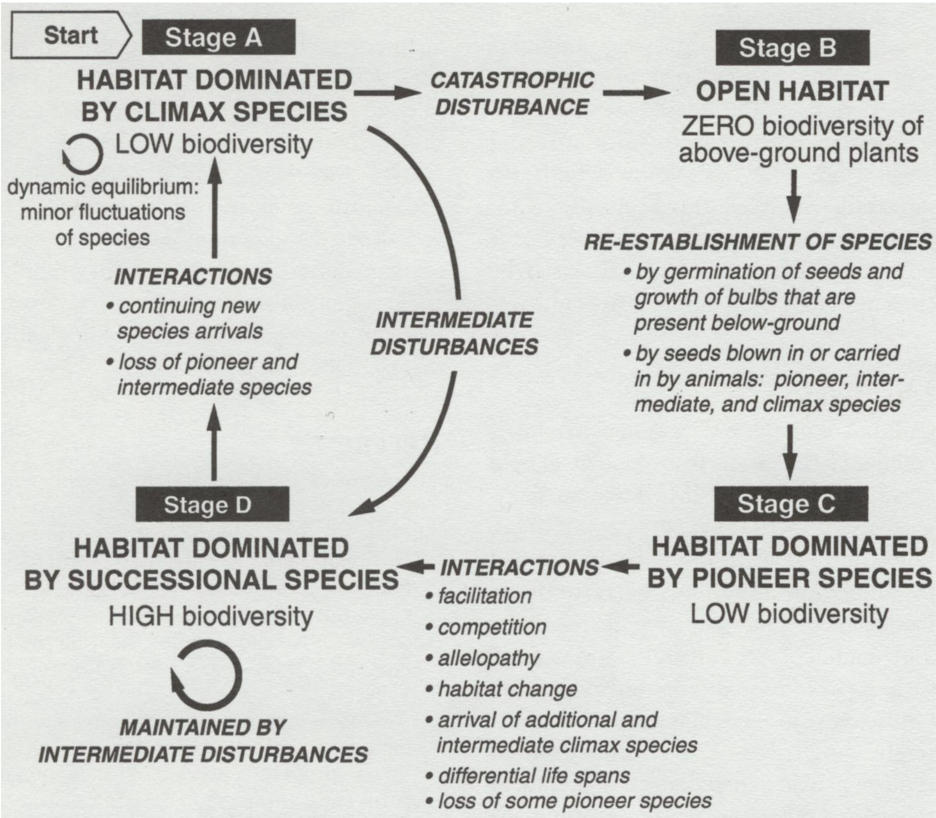

Figure 4. Diagrammatic summary of vegetation succession. A, B, C, and D are habitat and vegetation stages. Stage D demonstrates the intermediate disturbance hypothesis. The authors postulate that stage D represents the stage typified by Native American land management.

record. More of this kind of research could be done within national parks to join natural and cultural resource specialists in projects with shared goals (Ruppert 2001).

Ethnoecological Assessments

We propose that a new study document, called an ethnoecological assessment, should routinely be prepared for any area to be managed using a SIMM. An ethnoecological assessment extrapolates what is known about cultural uses and management of plants to the impact of such use and management at a population, plant community, or landscape scale (Bye 1979, Ford 1981). Such a study involves gathering ethnographic information that when integrated with other information from interdisciplinary studies could be used to reconstruct the manipulated landscape. Information would be gathered with sensitivity to screening and would censor information that the tribe considers confidential.

Ethnoecological assessments include 1) an inventory of the native plant and animal species gathered historically by a Native American tribe, their uses, and the relevant harvesting variables associated with these species; 2) documentation of former vegetation management practices employed by a Native American tribe for each useful native plant and animal species in the landscape, and the cultural objectives for specific management practices; 3) recording the cultural parameters necessary for the plant material to be suitable for preparation and manufacture, and comparing these specifications with the characteristics of raw plant materials gathered from unmanaged natural areas to elucidate former management practices; 4) documenting elders' perceptions of why native plant and animal species are disappearing and their memories of species' former abundance and distribution; and 5) recording estimates of the quantities of managed native plants/plant parts needed for the making of various cultural items in selected cultural use categories to ascertain the extent of former management practices.

We suggest that ethnoecological assessments, integrated with other interdisciplinary studies, will provide enough information to form the basis for developing ecological modeling approaches and ecological field experiments that mimic important Indian harvesting and management practices.

Ecological Modeling

Ecological modeling is a process of summarizing what is known about the requirements for a particular ecological outcome. For example, if the outcome is a yield of 1 ton of acorns per acre from an oak woodland, components of the model might well include the amount of annual precipitation, the depth of soil, tree density, the past occurrence of lightning-caused surface fires, the slope aspect of the hill on which the oaks grow, and the density of deer. The first approximation of an ecological model is anecdotal or conceptual—it is a diagram that includes these factors, shown as boxes and arrows that ultimately lead to the outcome. As more information becomes available, the model becomes quantitative and more predictive. For example, at this stage the researcher asks questions, such as: What range of precipitation is needed in inches of rainfall? How hot must the surface fire be and during which month must it burn? These quantitative details are obtained from field experiments, where each factor is altered and the effect on acorn yield measured. Thus an important role of a model is to direct research experiments. The results of experiments inform this model and improve it.

At the present time, most park natural resource managers have not included actions by indigenous people in their ecological models. We suggest that such models would be seriously incomplete for a SIMM-managed area. A SIMM of the same oak woodland would require using an eco-cultural model that included ecological data plus data about acorn quality (for example, the percentage of insect infestation), the traits of a human-set fire, and other outcomes that are simultaneously desired, such as increased oak sprouting for basketry material and increased numbers of edible mushrooms from mycorrhizal fungi.

Ecological Field Experiments

A SIMM is improved by experiments that quantify how indigenous people managed and affected nature. For example, do edible blue dicks (*Dichelostemma capitatum*) thrive when their parent corms are dug up and their cormlets are broken off and replanted? Do gooseberries (*Ribes* spp.) produce more edible fruits when burned periodically? Do edible mushrooms (*Morchella elata* and others) increase after the right kind of harvesting and burning? These questions can be tested through experiments that mimic indigenous management practices and measure the responses and yields to those techniques. By doing so, we move beyond the descriptive stage and begin to develop a quantitative model.

Setting up an experiment involves reconstructing and then simulating the management regime of a specific tribe in a designated area. It also involves establishing criteria for successful restoration of the plant, population or community, according to the tribe's cultural objectives for management. Then resource managers would establish biotic measures of success to achieve these desired outcomes. For example, the annual extent of damage to California black oak (*Quercus kelloggii*) acorns (an important food to tribes of the region) by filbert weevils and filbert worms in Sequoia-Kings Canyon National Parks is not yet predictable. Studies could be designed to measure pest incidence in acorns of black oaks in existing stands with known fire histories, and then field experiments could be conducted to determine the effect of simulated indigenous fire treatments on incidence of these insects. A quantitative SIMM would then be able to predict relationships between simulated indigenous burning and acorn quality as measured by the percentage of insect incidence.

Through well-designed long-term experiments, park resource managers will be able to distinguish between natural variation and low-level effects of indigenous perturbations on plants and vegetation. They will know whether a variable—such as flower production, acorn production, or young shoots for basketry—is enhanced or decreased by the simulated indigenous disturbance.

Discussion

Cultural and natural resource managers could take the results from ecological field experiments and the SIMMs to write management prescriptions for specific areas. Some of these areas would be maintained by simulating indigenous harvesting and management practices by park managers and called "eco-cultural landscapes." Others would qualify as ethnographic landscapes and be managed collaboratively with tribes. The treatments from ecological field experiments that best meet the desired outcomes of American Indians (as detailed in ethnoecological assessments) should be continued and modified as climate or other variables change. That is, if the manipulations that we are simulating bring about results that are antithetical to achieving desired cultural objectives, then those involved modify those manipulations. The management techniques are not static but rather are based on adaptive management.

If land managers, ecologists, and archaeologists understand the intricacies and mechanics of how and why native people shaped ecosystems, this will enrich their inventory of management methods, and they will be in a better position to make informed, historically based decisions. If the goal of the National Park Service is to preserve certain landscapes in some representation of their pre-contact structures and functions as outlined in the Leopold Report, then they can no longer ignore these anthropogenic effects and will have to consider the possibility of simulating some of these practices. Through the assemblage, integration, and interpretation of information from various disciplines, a sound research and management program could be designed to reintroduce simulated Native American management techniques, such as Indian-set fires within specific national park areas. We are suggesting that cultural and natural resource managers, ecologists, and Native Americans work together, using the methods of historical ecology, to reconstruct indigenous knowledge and management practices and then apply these regimes to various sites in order to recreate more authentic and biologically diverse historical landscapes.

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